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ANNUAL REPORT

OF THE

DIRECTOR

OF

THE ASTRONOMICAL OBSERVATORY

OF

HARVARD COLLEGE

FOR THE YEAR ENDING SEPTEMBER 30, 1918

BY

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## THE OBSERVATORY

TO THE PRESIDENT OF THE UNIVERSITY:—

SIR, — Two astronomical events have excited much popular interest during the past year. They furnish excellent examples of the policy of the Observatory — coöperation and thrifty management. The first of these events was the appearance of the New Star in the constellation Aquila, first seen on June 8, 1918, the second, the Total Eclipse of the Sun, the same day. The Observatory at once sent out cablegrams and letters, requesting observations of the brightness of the New Star, not only to Europe and America, but also to our correspondents in Africa, Japan, Australia, New Zealand, and the Sandwich Islands. As a result, including a few published observations, we have received 2094 estimates from 90 observers. Measures have been obtained on every night since its first appearance, and on many days when it was below the horizon in America. Thus, for the first time, a nearly continuous watch has been kept of a celestial object by a chain of observers extending around the Earth. Photographs taken here show its existence before its discovery, from May 22, 1888, to June 3, 1918. During this time it underwent slight variations in light. Three photographs on June 7, 1918, showed it of the sixth magnitude, about one hundred times its original brightness, and during the next day it again increased about two hundred times.

Eclipse expeditions are expensive with a prospect, if cloudy, that no results will be obtained. Even if clear, the result seldom justifies the cost. Accordingly, no expedition was sent at the expense of the Observatory. As, however, Miss Cannon desired to see the eclipse, a wooden photometer was furnished her, but, owing to clouds, results of importance were not secured.

Excellent results are being obtained from the two astronomical Fellowships. Some of these results are published in H.A. 84, Nos. 1, 2, and 3, and much more material is nearly ready for the printer. The Charles S. Hinchman Fellowship has been established by the generous gift of Mrs. Hinchman, and is now filled by Miss Mary D. Applegate. Miss Dorothy W. Block is the Edward C. Pickering Fellow.

The liberal coöperation of Professor Plaskett, mentioned in my last report, promises results of the greatest value. Excellent photographs taken with the 72-inch Telescope have been sent here,

which show that they will serve to determine the brightness of the faintest stars. We can thus materially extend the usefulness of this great instrument.

#### HENRY DRAPER MEMORIAL

The Henry Draper Catalogue has made good progress under the supervision of Miss Cannon. It has been printed and distributed as far as  $4^h 00^m$  in right ascension; it is in type as far as  $9^h 00^m$ ; the copy is completed as far as  $12^h 00^m$ ; the remainder is written and is nearly ready for the printer. To complete it, the "Remarks" must be written, and the photographic magnitudes determined.

Numerous requests for the results of this Catalogue have been received from astronomers in all the principal countries of Europe and the United States. The number of spectra sent in advance of publication exceeds 37,000. It will save time in supplying this material if the positions of the stars for 1900, or their identifications in the *Durchmusterung*, are given.

Numerous photographs of the spectra of Nova Monocerotis and of Nova Aquilae, No. 3, have been taken with the 8-inch Draper Telescope and 24-inch Reflector. With the latter instrument, plates stained with pinacyanol have been used, showing the  $H\alpha$  line.

The photographic observations at Cambridge have continued under the supervision of Professor King. The number of plates taken with the 24-inch Reflector is 179, making 2,109, in all; with the 16-inch Metcalf Telescope, 1,694, making 15,323, in all; with the 10-inch Metcalf Telescope, 1,501, making 2,513, in all; with the 8-inch Draper Telescope, 193, making 39,487, in all; with the 1-inch Cooke Anastigmat, 1,330, making 20,550, in all; with the 0.5-inch Voigtländer, 1,328, making 17,602, in all. The total number of plates exposed was 8,052, of which 7,155 were photographs of the stars. Adding to these the photographs taken in Arequipa, the total number of plates taken since 1884 is approximately 273,472. Among them, 173 good plates for determining the position of the Moon, 5 of Uranus, and 5 of Neptune have been obtained. Besides these, 897 enlargements, copies, etc., have been taken, making 29,743, in all. Measures of the light of the sky have been continued, especially during the period of coal shortage, when many street lights were extinguished. To save coal, the main building of the Observatory was closed for several weeks.

## BOYDEN DEPARTMENT

The Arequipa Station has continued under the charge of Mr. L. C. Blanchard, who has carried on a large amount of work without assistance. The principal work of the Bache Telescope has been taking the photographs in series needed to determine the photographic magnitudes of southern stars. This instrument has now been replaced by the 10-inch Metcalf Telescope, which gives much better images and a larger field. It is expected that results of great value will thus be obtained. The number of plates taken with the 24-inch Bruce Telescope is 86, making 11,808, in all; with the 10-inch Metcalf, 219, making 2,732, in all; with the 8-inch Bache, 1,445, making 53,082, in all; with the 1-inch Cooke Anastigmat, 837, making 14,466, in all. The total number of photographs of the stars is 3,355.

The Mandeville Station of the Harvard Observatory has continued under the direction of Professor W. H. Pickering. A considerable portion of the time of the 11-inch Draper Refractor was given to the study of Mars, in connection with the work of the other members of the International Association, and a reasonable non-artificial explanation of the formation and seasonal shifting of the more prominent canals has been found. Three reports, Nos. 18, 19, and 20 have been issued, and a fourth is now under preparation. An investigation of the shifting bright areas in the lunar crater Plinius, and of the changing visibility of the minute craters in Plato has been made. Further measures of the colors of the stars and planets have been secured, and a further study made of the telescopic indications of the approach of distant hurricanes.

The zenith equatorial for the rapid determination of the seeing has been completed, and it is found that the instrument can be opened, a zenith star found, the quality of the seeing determined, and the instrument closed, without undue haste, in an interval of three minutes. This instrument is particularly useful in connection with planetary observations, where a high quality of seeing is demanded. A study of Daylight Seeing at different hours for solar observations has also been made with this instrument. Numerous observations of the Gegenschein and Zodiacal Band have been secured. A number of observations of the brightness and color of Nova Aquilae were made, and its maximum brightness determined under rather favorable conditions, owing to the possibility of comparing it with our recollections of Canopus, which was only slightly fainter, and which rises well above the southern horizon in the winter season.

## BLUE HILL METEOROLOGICAL OBSERVATORY

The observational and routine work has been carried on during the year, and a series of thirty-two consecutive years of data made available through the published summaries in H.A. 83, Part 2. Actual and sensible temperature, pressure expressed in units of force, humidity, wind direction and velocity, night cloudiness, rainfall, snowfall, evaporation, and phenological phenomena showing the progress of the season have been recorded without interruption. No special papers were published although some investigations on wind as a factor in evaporation were carried on.

A summary of the mean monthly and yearly temperatures expressed in the Kelvin kilograde scale was prepared and published for the purpose of showing the saving in composition and the gain in accuracy as compared with the Fahrenheit scale. This is of importance in the presentation of climatological data; and in this, as in other matters, Blue Hill Observatory is playing the rôle of pioneer. It is essential that in all upper air work a scale of this nature be used owing to the frequency of occurrence of temperatures below the freezing point of water. In the Kelvin kilograde scale the zero is the absolute zero and the freezing point of water under standard pressure 1000. No degree symbols are used, that symbol being reserved for angular measures.

Much educational work was accomplished for the benefit of the United States Navy in the way of training young officers in Aerography. Fifty ensigns have taken the course. Professor McAdie was absent on foreign service for about six months.

## PHOTOGRAPHIC MAGNITUDES

The determination of photographic magnitudes on the International Scale has continued under the supervision of Miss Leavitt. Series of twelve plates each, two being on the North Pole, are taken, and a diffraction grating over the objective gives an independent measure of the magnitude. The number of series taken with the 10-inch Metcalf Telescope is 44 with blue light, and 24 with yellow light. The corresponding numbers taken at Arequipa, with the 8-inch Bache Telescope, are 87 with blue and 34 with yellow light. The principal work now in progress with these photographs is the determination of the magnitudes of sequences for the regions adopted as standards by the Committee of the International Chart of the Sky, for Kapteyn's Selected Areas and Special Areas, and for a large number of regions near clusters,

novae, variables, and other objects of special interest. About 72,000 estimates have been made of the brightness of stars in standard sequences and catalogues, and 18,000 of twenty-six novae and variable stars.

#### VARIABLE STARS

Professor Bailey has completed his study of four of the globular clusters,  $\omega$  Centauri, and Messier 3, 5, and 15. A beginning has been made of the study of the thirteen other clusters which are known to contain variable stars. The total number of distinctively globular clusters is 77, and it appears probable that the list is essentially complete, as no others have been found during the last half century. Unfortunately, 44 of these are south of  $-25^\circ$ , and only 33 are north. About fifty photographs of each cluster are desired for a satisfactory study of the variables. With a large reflector, suitable photographs can be obtained in five or ten minutes. The erection of such an instrument in the southern hemisphere is an urgent need. Its work during a single night would provide material for months of study.

With the polarizing photometers attached to the 15-inch Equatorial, Mr. Leon Campbell has made 9,352 settings, including 2,752 on the asteroid Eunomia, 400 on Iris, 1,152 on Uranus, 1,488 on the new star in Aquila, and 258 on the satellites of Jupiter on five nights while undergoing eclipse.

By friendly coöperation, the observation of variable stars has been greatly extended. Mr. C. L. Brook has sent us important results of observations by the British Astronomical Association. The work has been extended to the variables when faint by Professor S. A. Mitchell, Director of the McCormick Observatory, and Professor H. C. Wilson, Director of the Goodsell Observatory. Excellent results for southern stars, hitherto much neglected, have been obtained through Mr. J. F. Skjellerup from the Cape Astronomical Society, Mr. Baldwin, Director of the Melbourne Observatory, and Professor Dawson, of the La Plata Observatory. The total number of observations is 2,589. The American Association of Variable Star Observers has contributed 16,113 observations. In all, 22,478 observations have been made or received here, distributed as follows:—

W. J. Luyten, 4,289; L. Campbell, 1,744; H. A. Bancroft, Jr., 1,637; C. Y. McAteer, 1,433; T. C. H. Bouton, 1,330; J. F. Skjellerup, 974; B. H. Dawson, 830; G. B. Lacchini, 804; Ed. de Perrot, 743; M. A. Hawes, 708; A. W. Long, 615; McCormick Observatory, 592; C. T. Whitehorn, 558; E. H. Vogelenzang,

550; A. S. Young, 425; L. Peltier, 418; H. W. Vrooman, 391; S. C. Hunter, 340; C. S. Mundt, 340; G. Houdard, 319; D. B. Pickering, 291; H. C. Wilson, 257; W. J. Delmhorst, 213; W. P. Meeker, 207; J. M. Baldwin, 170; W. T. Olcott, 153; A. B. Burbeck, 148; M. H. Vann, 129; D. W. Block, 115; A. T. Bolting, 109. Besides these, 634 observations were communicated by twenty observers, each of whom made less than 100 estimates.

In addition, the following have contributed observations of the Nova in Aquila: —

E. E. Barnard, 151; L. Lapaz, 93; F. de Roy, 80; N. V. Ginori, 50; R. E. DeLury, 48; F. P. Leavenworth, 44; J. C. Duncan, 44; J. A. Pearce, 41; W. Beal, 41; V. Francis, 38; G. O'Hare, 33; J. Paci, 29; S. A. Rhorer, 28; O. Mach, 26. Besides these, 267 observations were contributed by 38 observers, each of whom made less than 25 observations.

#### MISCELLANEOUS

*Phillips Library.* — The Library of the Observatory has been increased by 172 volumes and 2,165 pamphlets. As 832 pamphlets have been bound in volumes, the present extent of the library is 15,244 volumes and 36,844 pamphlets.

*Telegraphic Announcements.* — Fourteen announcements of astronomical discoveries have been sent to astronomers in Europe and South America. Code messages are not permitted by the censors and, accordingly, orbits and ephemerides cannot be sent. It is requested that announcements be sent here, as usual, cablegrams addressed "Observatory, Boston," and telegrams, "Harvard College Observatory, Cambridge, Mass." They will be given as wide a distribution abroad as practicable. Our telegrams are sent at cost to all who wish for them.

Twenty-four Bulletins have been issued, making 669, in all. The restriction in cablegrams gives them an increased value. They are printed promptly and not only contain all the telegraphic announcements, but much additional information sent for that purpose. They are sent without charge to all receiving the telegrams, and at a price less than cost to all others desiring them.


*Publications.* — During the last year, Volumes 79, Part 1, Observations of Three Hundred and Twenty-Three Variable Stars of Long Period during the Years 1911-1916; 80, No. 10, Eclipses of Jupiter's Satellites; 80, No. 11, Photographic Determinations of the Position of the Moon; 80, No. 12, The Light Curve of W Virginis; 80, No. 13, Magnitudes of the Cape Photographic Durch-



musterung, No. II; **83**, Part 2, Observations and Investigations made at the Blue Hill Meteorological Observatory in the Year 1917; **84**, No. 3, Six Circumpolar Variables; **91**, The Henry Draper Catalogue, 0<sup>a</sup>, 1<sup>a</sup>, 2<sup>a</sup>, and 3<sup>a</sup>, have been distributed. Volumes **78**, Part 3, Variable Stars in the Cluster Messier 15; **81**, No. 1, Proper Motions of the Stars in the Zone  $-9^{\circ} 50'$  to  $-14^{\circ} 10'$ ; **82**, No. 1, The Harvard Station in Jamaica; **82**, No. 2, Measures of Close Double Stars with a Small Telescope; **92**, The Henry Draper Catalogue, 4<sup>a</sup>, 5<sup>a</sup>, and 6<sup>a</sup>; **93**, The Henry Draper Catalogue, 7<sup>a</sup> and 8<sup>a</sup>, are partly in type or at the printer's. The number of the Durchmusterung of Selected Areas, now being printed in Holland, has been changed from **85** to **101**. The set of Annals from **1** to **80** is, therefore, complete and distributed with the exception of **79**, Part 2. Volumes **83**, Parts 1 and 2, **84**, Nos. 1, 2, and 3, and **91**, are also published. Nine circulars have been issued, whose numbers, titles, and dates are as follows: —

202. Maxima in 1918 of Variable Stars of Long Period. November 30, 1917.
203. Asteroids Bright in 1918. January 9, 1918.
204. Nova Persei, No. 2. 032443. December 18, 1917.
205. The Distance of the Great Nebula in Orion. December 19, 1917.
206. The Distance of the Pleiades. The Distance of Coma Berenices. March 5, 1918.
207. A New Variable Star of Short Period,  $+37^{\circ} 4717$ , H. V. 3435. June 10, 1918.
208. The New Star, 184300, Nova Aquilae, No. 3. July 23, 1918.
209. The Spectrum of Nova Monocerotis, 072106. September 17, 1918.
210. Illustrations of Nova Aquilae, No. 3, 184300. September 17, 1918.

EDWARD C. PICKERING, *Director*.



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